EXTENSION NOTE

forest sciences
NELSON FOREST REGION

March 2000 EN-051

Shelterwood Harvesting in Root Disease Infected Stands in Southeastern British Columbia: Three-Year Results—EP 1186

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■ **A preliminary analysis of understory light conditions show that post-harvest light levels in all treatment units were acceptable for conifer growth.**

An analysis of the decomposition of forest litter at one or two years post-harvest showed only minor differences between treatments.

■ **Mortality and growth of seedlings were not affected by the root disease treatment (pushover falling) after three years. However, there was a trend of increasing seedling growth (including advanced regeneration) with decreasing residual basal area.**

INTRODUCTION

In the summer of 1993, the Forest Sciences Section of the Nelson Forest Region initiated an interdisciplinary research project (EP 1186) to test the use of partial cutting and root disease treatments in root disease infected stands in southeastern British Columbia (BC). The study stands are in the Columbia Shuswap variant of the Interior Cedar-Hemlock moist warm biogeoclimatic subzone (ICHmw2) and the Kootenay variant of the Interior Cedar-Hemlock moist cool subzone (ICHmk1).

The study is being conducted on two sites: the site at Mount Seven, near the town of Golden, is infected with Tomentosus root disease; the site at Ice Road, near the town of Burton, is heavily infected with Armillaria root disease. Conventional or pushover harvesting techniques were implemented in 1-ha treatment units prescribed as clearcuts, light retention shelterwoods, or heavy retention shelterwoods.

Harvesting was completed at the Mount Seven site during the winter of 1994/95; treatment units were planted in the spring of 1995 and the seedlings were measured. The seedlings were again measured after the first, second, and third growing seasons (in the fall of 1995, 1996, and 1997).

The Ice Road site was harvested during the winter of 1995/96; activities at this site follow the same pattern as for Mount Seven, but with a one-year lag.

This summary outlines initial findings for the following study components:

- Evaluation of understory light conditions.
- Preliminary results of the forest litter decomposition analysis.
- Preliminary results of the regeneration analysis, after three growing seasons.

For greater detail about study objectives, project design, harvesting operations, and post-harvest assessments see DeLong (1995) and Nelson Forest Region (1996).

UNDERSTORY LIGHT CONDITIONS

In the summer of 1997, fisheye photographs were taken at selected locations at the Ice Road site in order to characterize ambient light conditions following harvesting. (Understory light at the Mount Seven site was not studied.) Locations included one clearcut unit, two light shelterwood units, two heavy shelterwood units, and two control treatment units. A computer program called GLI-C was then used to analyze the images and estimate the light conditions at 1 m above the forest floor during the growing season. GLI-C provides estimates of the global light index (GLI), which is a measure of total light available during the growing season (direct and diffuse) for each treatment type.

Results show that, as expected, light levels increase as a stand becomes more open; however, total basal area was not a good predictor of understory light levels because of the large variation in crown shapes, sizes, and densities in mixed-species stands. Results suggest it is better to use the basal area of each species as separate independent variables when estimating light levels.

Light levels in the control units were found to be lower than those required for growth of most conifer species. However, post-harvest light levels in all the treated units, including heavy retention shelterwoods, were acceptable for conifer growth.

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Additional photographs will be taken at other locations at the Ice Road site, and quantum sensors will be installed to provide data for local calibration of results (i.e., to calibrate estimates from fisheye photographs with actual measured light levels).

FOREST LITTER DECOMPOSITION

The rate of decomposition of several types of forest litter is being studied at both the Mount Seven and Ice Road sites to determine the effects of various silvicultural systems and harvest methods on decomposition. Mesh bags containing pre-weighed amounts of various types of forest litter were placed on the ground in a number of treatment units, and left for one or two years before being collected and re-weighed.

Results from the Mount Seven site show no significant differences between the treatments after one year. After two years, there were significant differences only in the mass of remaining Douglas-fir needles compared to that of the other four litter types being studied (aspen leaf litter, forest floor litter, lodgepole pine needle litter, and green spruce needles).

Litter loss from mesh bags in control units (unharvested) at Mount Seven was less than losses from most of the harvested plots. There were also some indications that litter decomposed faster in pushover plots (where bags were located on mineral soil) than in conventionally harvested plots (where bags were located on forest floor); however, there were no significant differences.

At the Ice Road site, three different types of litter were studied: lodgepole pine needle litter, western larch foliar litter, and aspen leaf litter. Unlike the Mount Seven results, after one year, there was a tendency for mass loss to be greatest in the control units and least in the clearcut units; but, the difference was significant only for the pine needle litter. There was no consistent trend for differences between pushover and conventionally harvested plots at the Ice Road site, and no significant differences between these treatments.

In an additional analysis where the data were combined for the Mt. Seven and Ice Road sites, there were significant differences between the two areas, but no overall treatment differences were revealed. The study is ongoing.

REGENERATION

The regeneration component of EP 1186 assesses survival and growth of planted, advanced, and natural regeneration (germinants). The following information summarizes the results after the third growing season, from both study locations.

Mount Seven: Planted Seedlings

Survival

Douglas-fir, larch, and spruce seedlings were planted in sample plots at the Mount Seven site in spring 1995. Average mortality of planted seedlings after three growing seasons is 13% (Figure 1). The annual mortality rate was lower after the third growing season (fall 1997) than after the second growing season (1996), and remaining seedlings generally showed good vigour.

Results showed little difference in total mortality between treatments and no apparent trends; however, spruce showed significantly lower mortality than either larch or fir. Larch and fir both showed moderate mortality regardless of treatment—although larch mortality increased slightly with increasing overstory—which may indicate poor planting stock, or, in the case of larch, poor site suitability.

Vigour

Surviving seedlings generally had good vigour, and the data showed no trends in seedling vigour between treatments. Douglas-fir seedlings were not quite as vigourous as larch and spruce; however, after the third growing season an average of more than 70% of the seedlings remained in good condition.

Damage

None of the damage observed on seedlings to date is considered serious and seedlings will likely outgrow most of it (i.e., forked stems and chlorotic foliage). The most common type of damage—forked leaders—occurred in all species but was most frequent on Douglas-fir. The problem was observed across most of the treatment types and is likely related to stock or other factors, rather than treatment.

Growth

Statistically significant differences in height growth between species were observed (Figure 2). Height growth of larch was greater than that of either spruce or Douglas-fir, even in heavy retention shelterwoods, which suggests the trend is at least in part the result of larch growth form. The slightly drier climate and more exposed location than that found at Ice Road may be contributing to the relatively good growth of larch, and absence of larch needle cast.

After three growing seasons, differences in height increment between treatments were not yet significant, but seedlings were beginning to differentiate and it is likely that by the five-year re-measurement period, differences between treatments will be significant. Analysis of seedling diameter growth showed similar results.

Mount Seven: Advanced Regeneration

Height increment of advanced regeneration was analyzed after the fifth growing season (fall 1999), and these results will be published in another Extension Note. Height of advanced regeneration after the third growing season (fall 1997) was compared by species for the different treatments; results show that species heights between treatments are reasonably similar, so it should be possible to determine treatment-based differences over time.

Mount Seven: Germination

Germination frequency at this site shows considerable variation from year to year, and between treatment types. Both second- and third-year results show an apparent trend towards increasing germination frequency with increasing level of overstory retention (with the exception of control blocks), as well as a slight trend towards increased germination on pushover blocks compared to conventionally harvested blocks. Heavy retention shelterwoods had substantially greater germination than other blocks, possibly reflecting to some degree the readily available seed supply.

Ice Road: Planted Seedlings

Survival

In the spring of 1996, Douglas-fir, western larch, and western redcedar seedlings were planted in sample plots in each of the treatment units (except controls) at the Ice Road site. Mortality, vigour, damage, and growth were analyzed after three growing seasons (fall 1998) (Figure 3).

Results show statistically significant differences in mortality for the three species, with larch suffering by far the greatest amount (45%), followed by Douglas-fir (11%) and cedar (1%). There were also statistically significant differences in mortality between clearcut units and heavy shelterwoods, although no differences occurred between units that were harvested by conventional and pushover methods.

Larch mortality was not consistent across treatment types, and the variability suggests the problem is environmental (treatment related) rather than stock related. The likely cause is a foliage disease—probably larch needle cast—which was observed on most of the surviving seedlings after the second growing season (fall 1997). The seedlings in the shelterwood blocks may have been under stress due to reduced light conditions and larch needle cast, and therefore may have been more susceptible to mortality over the summer of 1998, especially given the relatively hot and dry weather. The incidence of foliage disease was much lower after the third growing season (fall 1998) so it is hoped that most of the remaining larch seedlings will survive.

Vigour

After three growing seasons, seedlings of all species showed a trend of increasing vigour with decreasing levels of overstory retention, but the trend was much more pronounced for larch.

Western redcedar vigour was predominantly good regardless of treatment type. Douglas-fir vigour was generally good or medium (depending on level of overstory retention), and only a small proportion of seedlings showed poor vigour. Larch vigour, though still often poor, was greatly improved relative to the two-year results. This improvement in larch vigour is likely due in part to the high level of mortality over the third growing season (i.e., many of the stems that were previously in poor condition died), and also because the seedlings were beginning to acclimatize to their new environment.

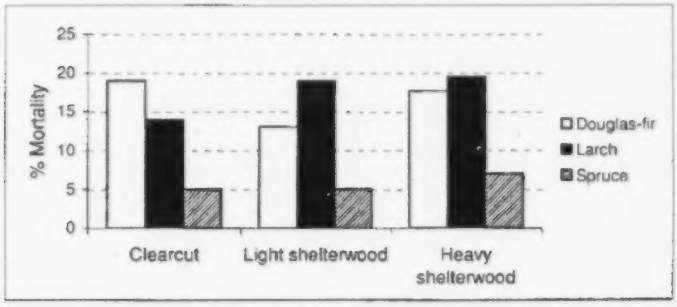

Figure 1. Cumulative mortality of planted seedlings after three growing seasons (fall 1997), Mount Seven site.

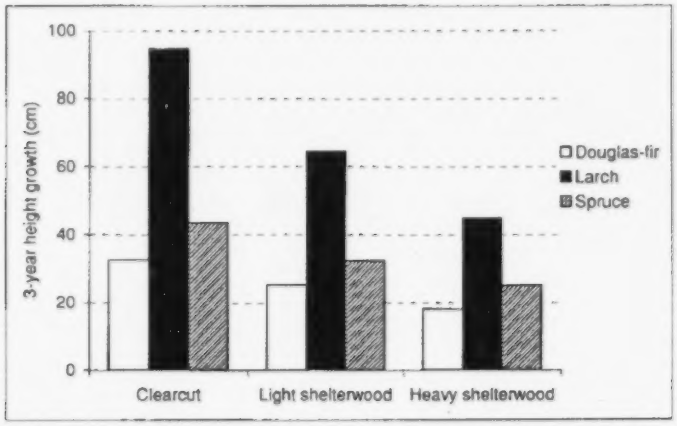

Figure 2. Height growth of planted seedlings after three growing seasons (fall 1997), Mount Seven site.

Damage

No serious damage or stress indicators were found on the planted seedlings after three growing seasons, with the exception of thin foliage on some of the larch which may be related to larch mortality at the site. Some additional mortality in the larch occurred after the third growing season (fall 1998) because many were still showing poor vigour and signs of stress (thin foliage); however, mortality was substantially reduced. Only minor browsing by deer was noted in the third-year assessment.

Growth

After three growing seasons, statistically significantly differences in seedling growth were evident between species and silvicultural systems, but not between harvesting methods (Figure 4). Seedling height increment was significantly different for all three silvicultural systems. In general, height increment increased as level of overstory retention decreased, as was expected. Results also showed a significant difference in height increment for western redcedar compared to Douglas-fir or larch, with cedar generally showing greater height increment than the other two species.

Figure 4 shows the effects of both species and silvicultural system on height growth, and it illustrates the effects of poor larch vigour on height growth especially well. Under better conditions, larch would have surpassed Douglas-fir in total height (given its faster growth form); however, the average height increment of larch was slightly less than that of both Douglas-fir and cedar on the shelterwood sites, and even in the clearcut blocks it was not growing as well as would be expected. It appears that when the larch seedlings are located in favourable microsites they grow very well; but, as light levels decrease, and other factors such as larch needle cast come into play, growth is substantially reduced

Diameter growth showed the same trends as height growth, with average diameter growth decreasing as level of overstory increased. Differences in diameter growth were statistically significant between all three silvicultural system treatments, and there were significant differences between larch and the other two species.

Ice Road: Advanced Regeneration

A subset of advanced cedar regeneration was used as the sample set for analysis of advanced regeneration at this site. Analysis of variance shows that the silvicultural system had a significant effect on height increment (Figure 5). Height increment in control blocks was significantly different from that of clearcut and light shelterwood blocks,

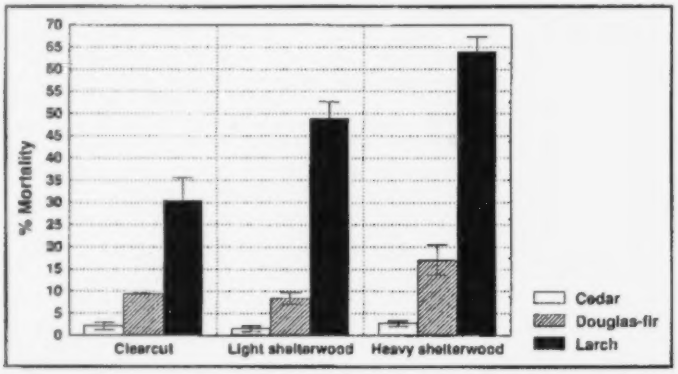

Figure 3. Cumulative mortality of planted seedlings after three growing seasons (fall 1998), Ice Road site.

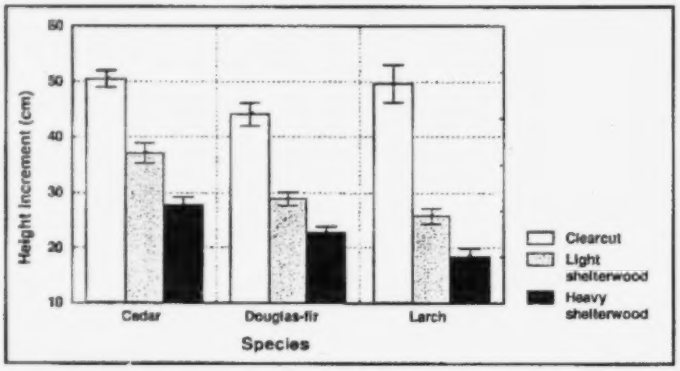

Figure 4. Height growth of planted seedlings after three growing seasons (fall 1998), Ice Road site.

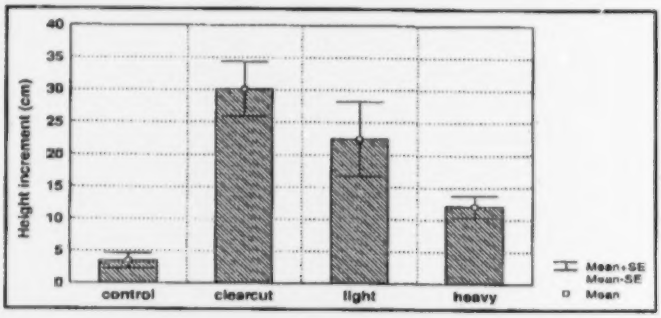

Figure 5. Height growth of advanced cedar regeneration after three growing seasons (fall 1998), Ice Road site.

and height increment in heavy shelterwoods was significantly different from that in clearcuts.

Ice Road: Germination

No trends are obvious, therefore it is not possible to relate germination occurrence to either harvesting method or level of overstory retention. There was substantial variation in germinant occurrence within each treatment.

SUMMARY

Pushover falling appears to have had no effect on the mortality and growth of seedlings to date, and there were only minor differences in decomposition rates between treatments. Understory light conditions in all treatments are acceptable for conifer growth, however there is a trend of increasing growth with decreasing residual basal area for both planted and advanced regeneration. Measurements are continuing through to Year 5, and the results will provide further guidance to forest managers when prescribing partial cuts.

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ACKNOWLEDGEMENTS

Support from the Science Council of BC and Forest Renewal BC, as well as assistance from the staff at the Nakusp Field Office, are gratefully acknowledged.

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